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Fifty Years of American Mathematics: PROFESSOR GEORGE D. BIRKHOFF 461

Obituary:
Guy N. Collins: J. H. KEMPTON. *Recent Deaths and Memorials* 467

Scientific Events:
United States Standards in Argentina; The Annual Meeting of the American Society of Mechanical Engineers; The Mathematical Association of America; Award of the Penrose Medal to Professor Lawson 468

Scientific Notes and News 470

Discussion:
A Measure of the Flight Capacity of Grasshoppers: PROFESSOR J. A. MUNRO and STANLEY SAUGSTAD. *Authority Citations Again:* DR. JOSHUA L. BAILY, JR. *A Reversed Cat:* HELEN A. WRAGG. *Elliptical Erythrocytes:* DR. M. C. TERRY. *M(anille) Ide, the Discoverer of "Bios":* PROFESSOR ROGER J. WILLIAMS 473

The National Academy of Sciences:
Abstracts of Papers Presented at the Chapel Hill Meeting 475

Special Articles:
The Secretion of Iodine by Thyroid Glands Cultivated in the Lindbergh Pump: DR. LILLIAN E. BAKER. *Photographic Nature of Tanning of the Human Skin as Shown by Studies of Male Hormone Therapy:* DR. JAMES B. HAMILTON and DR. GILBERT HUBERT. *Action of Vanadium on Tissue Oxidations:* DR. FREDERICK BERNHEIM and DR. MARY L. C. BERNHEIM. *A Comparative Study of the Subterranean Members of Three Field Grasses:* DR. HOWARD J. DITTMER 479

Science News 10

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FIFTY YEARS OF AMERICAN MATHEMATICS[1]

By Professor GEORGE D. BIRKHOFF
HARVARD UNIVERSITY

IT is indeed a great honor to participate in this semi-centennial celebration of the founding of the New York Mathematical Society in 1888, which became in 1894 the American Mathematical Society. As one of the speakers I have set myself the challenging task of tracing our mathematical development under the auspices of the society during the years which have passed. Obviously in such a *coup d'oeil* only the principal factors involved can be alluded to, and the point of view adopted must necessarily be more or less personal.

At the very outset it is well to recall the general mathematical background of our country at the time when the society came into existence. In colonial days scientific and mathematical knowledge had a certain definite standing, largely for its practical value but in part also for its own sake. George Washington was a scientifically minded gentleman farmer for much of his life, and in his youth was a skilled surveyor, familiar with trigonometry; Benjamin Franklin discovered experimentally the electrical nature of the lightning discharge, theorized concerning electricity as a fluid, and had enough mathematical interest to devise ingenious magic squares; Thomas Jefferson regarded geometry and trigonometry as "most valuable to every man," algebra and logarithms as "often of value," while he classed "conic sections, curves of the higher orders, perhaps even spherical trigonometry, algebraic operations beyond the 2d dimension, and fluxions" as a "delicious luxury"; in his later years Jefferson spent much of his time in mathematical reading, and was ever a true friend of mathematics. The interest in science and mathematics continued to be genteel and amateurish among American scholars and devotees until towards the middle of the last cen-

[1] Opening portion of an address delivered at the semi-centennial celebration of the American Mathematical Society, New York City, September, 1938.

tury, with few notable exceptions. The best mathematicians of those days looked appreciatively toward Europe without much thought of high emulation.

Then came a gradual change in the temper of the times, which led to the formation of our society. Characteristic of this change were the outstanding figures of Benjamin Peirce, of Josiah Willard Gibbs and of George William Hill. Peirce died in 1880, Gibbs in 1903 and Hill in 1913, having been fourth president of the society in the years 1894 to 1896. But it was the contagious enthusiasm of a group of young Americans, returning from mathematical studies in Europe, which proved the immediate cause of the formation of our society; and in this so important enterprise Thomas Scott Fiske, seventh president of the society, and Frank Nelson Cole, long its devoted secretary, took leading parts. The year 1888 of our beginning as a professional body devoted to the interests of research marks with precision our coming to a fitting mathematical position among the nations of the earth.

Of the three figures mentioned it was Benjamin Peirce who was by far the most influential in America as a scientific personage. I remember a talk about Peirce with his last pupil, the late Dr. Leonard Waldo, mathematical meteorologist. Waldo said that the first sight of Peirce seated behind his desk at home rendered him quite speechless. Ex-President A. Lawrence Lowell, of Harvard University, fell under Peirce's mathematical spell while an undergraduate and wrote a few years ago: "Looking back over the space of fifty years since I entered Harvard College, Benjamin Peirce still impresses me as the most massive intellect with which I have ever come into close contact, and as being the most profoundly inspiring teacher that I ever had. His personal appearance, his powerful frame and his majestic head seemed in harmony with his brain."

Benjamin Peirce's papers on "Linear Associative Algebra," announced at the first meeting of the American Association for the Advancement of Science in 1864, give him a just claim to be considered an eminent mathematician. His researches in this field were made at a time when English and American mathematicians looked upon the great invention of quaternions by W. R. Hamilton as a supreme achievement, destined to be of incalculable importance for mathematics and physics. Peirce saw more deeply into the essence of quaternions than his contemporaries, and so was able to take a higher, more abstract point of view, which was algebraic rather than geometric. However, he was much more than an algebraist, for he was well informed about some of the most significant mathematical developments of his day. His volumes, "Curves, Functions, and Forces," testify to a real interest in the function-theoretic work of Cauchy, albeit somewhat superficial in character. His large book, "Analytical Mechanics," showed that he had read and mastered the works of Hamilton, Jacobi and others in the extensive field of dynamics. In addition, he was skilled in the theory and methods of computation useful for dynamical astronomy, and spent a considerable amount of time during later years in a somewhat unhappy attempt to show that Leverrier and Adams had no adequate basis for the calculations leading to the celebrated discovery of the planet Neptune; one naturally calls to mind the calculations by the eminent astronomer, the late Percival Lowell (brother of A. Lawrence Lowell), which brought about the discovery of the small planet Pluto in 1930, since these calculations have also been occasionally criticized for similar reasons.

Despite Peirce's remarkable ability to inspire especially capable and advanced students, he was not regarded as a good teacher for the rank and file; a characteristic feature of his lectures was a reaching toward seemingly endless vistas of abstract generalizations.

Josiah Willard Gibbs was a man of modest and not especially impressive personality, who did far more to advance physics and chemistry through his work on statistical mechanics and the equilibria of chemical systems than Peirce ever did for pure mathematics. Gibbs's title to be considered a mathematician rests mainly upon his largely notational contributions to vector analysis, a subject also closely related to Hamilton's quaternions. The late Maxime Bôcher, who with William Fogg Osgood really succeeded Peirce at Harvard, later attached the name of "Gibbs's phenomenon" to a fundamental fact about Fourier's series which was observed by Gibbs; this is related to the peculiar behavior of the successive curves of approximation $y = s_n(x)$ to a discontinuous function near the point of discontinuity. As has happened from time to time here and elsewhere, the fundamental contribution of Gibbs's physical work was first recognized by admirers in other countries, in particular by James Clerk Maxwell, so that it was only somewhat tardily, by reflected light as it were, that Gibbs came to be properly appreciated in the United States.

George William Hill was a scientific figure of altogether unconventional type who spent more than three decades of his life as an assistant in the Nautical Almanac office in Washington and then went back to the place of his birth, West Nyack, N. Y., to continue his researches.[2] Hill, like Gibbs, never married. His life was devoted to what were essentially mathematical studies of the solutions of the three-body problem use-

[2] Professor R. C. Archibald has informed me that Hill lived in Washington only for ten years.

ful to the lunar theory and in making specific astronomical computations. His work on periodic motions was the worthy forerunner and inspiration of the splendid theoretical advances of Henri Poincaré in celestial mechanics, who thus owed much to Hill's achievements. The free introduction of infinite determinants by Hill in his celebrated papers on the restricted problem of three bodies was especially noteworthy, although it is only recently that this interesting analytic instrument has been perfected.

Of these men, Hill would be claimed for themselves by the theoretical astronomers, along with Nathaniel Bowditch, translator and commentator of Laplace's "Mécanique Céleste," and Simon Newcomb, great perfecter of lunar and planetary theory; while Gibbs would be justly taken by physicists and chemists for their own. Thus there remains to the mathematicians of America only Benjamin Peirce for their undisputed possession. He appears as a kind of father of pure mathematics in our country. In his deep appreciation of the elegant and abstract we may recognize a continuing characteristic of American mathematics. In his concern with its many applications there resides a virtue which we are finding it more difficult to realize, because of the trend towards professional specialization. Without doubt, however, there is a spiritual necessity upon us to-day to regain a similar breadth of outlook.

Any account, however brief, of American mathematics before 1888 must chronicle an event of the preceding decade which was of extraordinary importance not only to mathematics, but to the whole field of scholarly endeavor, namely, the foundation of the Johns Hopkins University at Baltimore in 1876. Although the Graduate Schools of Yale University (1847) and of Harvard University (1872) were in existence, nevertheless, as has been said by Dr. Abraham Flexner in his book, "Universities: American, English, German," the Johns Hopkins University was the first American institution "consciously devoted to the pursuit of knowledge, the solution of problems, the critical appreciation of achievement, and the training of men at a really high level." Thus there was called to the new mathematical department at Baltimore the great English algebraist, James Joseph Sylvester, who remained there until 1884. Under the direction of the department there began in 1878 the *American Journal of Mathematics*, our first journal given over to mathematical research, and now completing its sixtieth year of high achievement. Ever since, there has continued to be at Baltimore, despite material limitations, an important center of mathematical activity, of which the staunch and kindly remembered British geometer, Frank Morley, was the titular leader from 1900 to 1928.

In all previous mathematical history perhaps no mathematical development in any country has been so extensive and rapid as that which ensued here upon the founding of the society. All the great nations of Europe had produced illustrious mathematicians of whom they had the right to be extremely proud. The French and German mathematical traditions were particularly well established and of incomparable brilliancy, represented at that moment by Henri Poincaré, the young David Hilbert and a number of other figures of very high rank. Italy and the Scandinavian countries were also flourishing vigorously. Yet up to that time there had scarcely arisen any occasion for European mathematicians to note the work of their American colleagues. A solitary exception was the early recognition of Hill's lunar theory by Poincaré, while the algebraic advances of Peirce failed to receive the attention which they deserved.

But now able young mathematicians, fresh from studies abroad, began to carry on vigorous and independent research at home, and their contagious enthusiasm soon aroused a deep interest in the younger men around them. Almost over night, as it were, the great University of Chicago sprang into existence in 1892, with a mathematical department made up of Eliakim Hastings Moore, Oskar Bolza and Heinrich Maschke from Germany, and others. Of these men, only Bolza is living to-day. They formed a notable and inspiring group which will ever be remembered in our mathematical annals. At about the same time Osgood and Bôcher, inspired by their German sojourn and in particular by the great Felix Klein of Göttingen, bent their every effort to strengthen the tradition at Harvard. Under the genial leadership of Moore at Chicago, who had studied with Gibbs at Yale University and for a year in Berlin, there was emphasized the abstract and algebraic side of mathematics, although Moore was remarkably catholic in his outlook. At Harvard attention was turned towards the vast field of analysis. The center in Cambridge was much strengthened by the transference of the Massachusetts Institute of Technology from Boston across the Charles River in 1916. Its mathematical group and that at Harvard University have been in close and mutually stimulating association since that date.

A few years later, under the wise and benevolent guidance of Dean Henry Burchard Fine, who had been strongly influenced by his studies under Leopold Kronecker, promising young men were called to the mathematical staff at Princeton, in particular L. P. Eisenhart, Oswald Veblen and J. H. M. Wedderburn. From that day forth there has always been an important mathematical group at Princeton. There came a notable further impetus with the founding there in 1930 of the Institute for Advanced Study, with Abra-

ham Flexner as director. At the outset the new institute devoted its attention to the fields of mathematics and theoretical physics, calling at first Albert Einstein, Veblen and Hermann Weyl to ideal research posts. Up to the present time the mathematical staff of the institute has worked side by side with the staff of the university in Fine Memorial Hall. The others at the institute have in general already obtained their doctor's degree and come to enjoy a period of uninterrupted study and research under favorable conditions. The institute is fortunately able not only to augment its staff through distinguished temporary appointments, but also to give partial financial support to many of those who come to study.

By great good fortune I have been intimately associated with the centers at Chicago, Harvard and Princeton. I feel deeply indebted to them all. Indeed, there are not many American mathematicians who have not been profoundly influenced by one or another of these three groups. It was in the spring of 1902 that I made a first journey across the city of Chicago to the university, and found my way into the excellent mathematical library in Ryerson Physical Laboratory; before that time I had only been in contact with the mathematical books of the John Crerar Library and the small mathematical collection at Lewis Institute. I remember the thrill which the sight of the well-filled shelves gave me. Soon I met Professor Moore, of whom I had already heard, and found him then and always extraordinarily inspiring, suggestive and kind. During my first (junior) year at the university I profited much from my contact with Bolza also. At his suggestion I read the work of Gauss on the cyclotomic equation and the equally celebrated paper of Abel on the impossibility of solving the general quintic by radicals. Bolza's lectures were marvels of clarity and finish. But it was Moore above all who seemed to me to have the true fire of genius within him.

The year following I went to Harvard, with Moore's approval, for two years of study. There I learned more analysis, particularly from Osgood and Bôcher. I found Bocher's lectures the equal of Bolza's in lucidity and superior in placing important points in high relief. It was only later, however, that I came to realize how much I owed to Bôcher for his suggestions, for his remarkable critical insight and for his unfailing interest in the often crude mathematical ideas which I presented.

On my return to Chicago in the fall of 1905, I profited greatly by two further years of work with Moore, both in his seminar on analysis and outside the classroom. Moore was a deep admirer of Hilbert and was then following closely the rapid developments at Göttingen, attendant upon Fredholm's fundamental work in linear integral equations of 1900. It happened that I saw Moore's program of General Analysis taking shape day by day, as he came to appreciate the full abstract significance of the papers of Hilbert and the beautiful dissertation of Erhard Schmidt.

In 1907 I started teaching at the University of Wisconsin, and in my two years there I especially valued my scientific and personal relationship with my senior colleague, Edward Burr Van Vleck, whose distinguished son is now at Harvard as a member of the departments of physics and mathematics.

It was in the fall of 1909 that I became a member of the staff at Princeton. The presence of Veblen, nearly of my own age, with large ideas for American mathematics in general and for the Princeton Department in particular, meant much to me during my three years there. Veblen was then completing his important "Projective Geometry," volume 1, written in collaboration with J. W. Young, whom many will remember kindly. It was my privilege to read the book in page proof and to learn of Veblen's geometric program and ideas directly from him in our frequent walks and talks together.

I have recounted these personal circumstances only because I know that in their essence they are not very dissimilar to those of many American mathematicians.

In selecting Chicago, Cambridge and Princeton for especial reference I have realized fully that American mathematics reaches overwhelmingly beyond what is to be found in any three or even in any ten centers. And yet I think it is a comforting thought for American mathematicians everywhere to know that there are centers like these where scholarly conditions have been uniformly good and where high ideals have been steadily maintained. Such places, by their influence and example, support and stimulate mathematical scholarship and achievement throughout the whole of our country.

Concerning the other mathematical centers suffice it to say that there are now about thirty institutions where the advanced student of mathematics may go with advantage to study for the doctorate, while only fifty years ago he was forced to go to Europe to secure adequate training! Among the privately endowed institutions may be mentioned Brown, Bryn Mawr, California Institute of Technology, Chicago, Cincinnati, Columbia, Cornell, Duke, Harvard, Institute for Advanced Study, Johns Hopkins, Leland Stanford, Massachusetts Institute of Technology, Notre Dame, Princeton, Rice Institute and Yale; and among our state universities, California (at Berkeley and at Los Angeles), Illinois, Iowa, Michigan, Minnesota, Ohio State, Pennsylvania, Texas, Virginia and Wisconsin; and in Canada, the University of Toronto. The number of such centers should increase still further. All

that is required in many cases is that mathematicians in a position of influence take the proper steps. As instances in point, I would cite what was done by Fine at Princeton and by Harris Hancock at Cincinnati.

The extraordinary contrast between 1888 and 1938 is equally manifested by the fact that fifty years ago there was a mere handful of competent mathematicians in the country, whereas there is now a body of over two thousand American members of our society. Among these, between one and two hundred have gone far beyond a doctoral dissertation to make important additions to mathematical knowledge, and some forty or fifty are highly creative with established international reputations. Later on I shall have occasion to refer to a number of these mathematicians and their specific contributions.

For the moment, however, I should like to direct attention to two interesting and important special groups. The first is made up of mathematicians who have shown the rare quality of leadership, of which Moore was an outstanding instance. Among the earlier of these I would mention the late eccentric geometer, George Bruce Halsted, who attracted to mathematics two notable figures, L. E. Dickson and R. L. Moore, both of whom in their turn have been able to exert a large personal influence. I would also mention with high esteem James Pierpont, who for many years was a source of inspiration at Yale. Among the other and younger men, besides Dickson, R. L. Moore and Veblen, the names of G. A. Bliss, G. C. Evans, Solomon Lefschetz, Marston Morse, J. F. Ritt, M. H. Stone and Norbert Wiener come to mind as having shown the same quality to an exceptional degree.

The second special group to which I wish to refer is made up of mathematicians who have come here from Europe in the last twenty years, largely on account of various adverse conditions. This influx has recently been large, and we have gained very much by it. Nearly all the newcomers have been men of high ability, and some of them would have been justly reckoned as among the greatest mathematicians of Europe. A partial list of such men is indeed impressive: Emil Artin, Solomon Bochner, Richard Courant, T. H. Gronwall, Einar Hille, E. R. van Kampen, Hans Lewy, Karl Menger, John von Neumann, Oystein Ore, H. A. Rademacher, Tibor Radó, J. A. Shohat, D. J. Struik, Otto Szász, Gabor Szegö, J. D. Tamarkin, J. V. Uspensky, Hermann Weyl, A. N. Whitehead, Aurel Wintner, Oscar Zariski.

With this eminent group among us, there inevitably arises a sense of increased duty toward our own promising younger American mathematicians. In fact, most of the newcomers hold research positions, sometimes with modest stipend, but nevertheless with ample opportunity for their own investigations, and not burdened with the usual heavy round of teaching duties. In this way the number of similar positions available for young American mathematicians is certain to be lessened, with the attendant probability that some of them will be forced to become "hewers of wood and drawers of water." I believe we have reached a point of saturation, where we must definitely avoid this danger.

It should be added, however, that the very situation just alluded to has accentuated a factor which has been working to the advantage of our general mathematical situation. Far-seeing university and college presidents, desirous of improving the intellectual status of the institutions which they serve, conclude that a highly practical thing to do is to strengthen their mathematical staffs. For, in doing so, no extraordinary laboratory or library expenses are incurred; furthermore, the subject of mathematics is in a state of continual creative growth, ever more important to engineer, scientist and philosopher alike; and excellent mathematicians from here and abroad are within financial reach.

Having thus glanced at our mathematical firmament which shines so brightly to-day, let us turn to survey briefly the general situation in our country which has made it possible. In the year 1888 there were probably about two hundred thousand students in our high schools and preparatory schools; to-day there are between five and six millions. This enormous increase is a consequence of the unquestioning belief in higher education which pervades our country. At the same time our colleges, universities and advanced technical schools have increased correspondingly in numbers and resources. There are to-day nearly a thousand such institutions scattered throughout our land, serving well over a million students, with a total physical plant staggering the imagination and representing billions of dollars of endowment. Probably the majority of these institutions struggle along under financial as well as educational difficulties, although rendering distinct service. But when all is said and done, there remain some two hundred and fifty of them which meet the exacting requirements of approval by the Association of American Universities.

As far as the mathematical side of this vast American enterprise of higher education is concerned, its magnitude is probably best appreciated by means of a different approach. The American Mathematical Society has a membership of over two thousand persons, the great majority of whom hold positions in our institutions of learning. Our highly esteemed sister organization, the Mathematical Association of America, devoted primarily to the interests of collegiate mathematics, has nearly twenty-five hundred members.

The conclusion then is plain. There must be between two and three thousand mathematical teaching positions in our higher institutions, with an average salary which must certainly lie between two to three thousand dollars. We see in this way that there is probably a sum of about six millions of dollars which goes each year to the support of higher mathematics!

Since the great war salaries have been increased and the teaching burden has been reduced, at least in the better institutions. I remember talking some twenty years ago with the late J. C. Fields, of Toronto, about the status of professors throughout the world; it will be recalled that Fields did more than any one else to bring about the important International Mathematical Congress held at Toronto in 1924. He told me that, after making a special study of the facts, he had come to the conclusion that the American professor was the worst treated of all! At that time there was much in his contention, even though there were already in existence a number of American professorial chairs where the salary was good and the teaching duties not excessive. To-day there are many such positions. In this connection it may be well to mention the fact that Harvard University has been able to reduce the amount of teaching and tutorial routine of the regular mathematical staff to six hours a week, of which only three hours are devoted to more or less elementary mathematical instruction. Such a schedule gives to all concerned a notable opportunity to carry on mathematical research, and would be socially unjustifiable unless the highest standards of achievement were being maintained. Although such ideal conditions are impracticable at present except in a few fortunate institutions, it should be strongly emphasized that twelve hours of instruction a week (including at least one course of advanced grade) is about all that can be required if the best standards of scholarship are expected. Indeed, wherever possible, the hours of instruction should be reduced to not more than nine, and if there are heavy outside duties there should be a compensating diminution in teaching.

But the situation has very definitely a complementary aspect. On our part there is an unescapable, deep responsibility to the nation which, somewhat unwittingly perhaps, has afforded us such splendid support. It is our duty to take an active and thoughtful part in the elementary mathematical instruction of our colleges, universities and technical schools, as well as to participate in the higher phases. To these tasks we must bring a broad mathematical point of view and a fine enthusiasm. In so far as possible we must actively continue as competent scholars and research workers. Only by so doing can we play our proper part.

It is interesting to note that the other material accessories useful for our extensive mathematical edifice have also been provided. With our *Bulletin* and *Transactions*, with the *American Journal of Mathematics*, all under society auspices, and with the *Annals of Mathematics*, the *Duke Mathematical Journal*, the *Journal of Mathematics and Physics* and the *American Mathematical Monthly*, we possess excellent facilities for the publication of original articles in periodicals. Aside from the *Journal of Mathematics and Physics* there is as yet no journal directed towards applied mathematics. More extensive publication in book form is afforded by our Colloquium Publications, and a similar new series in contemplation by the Institute for Advanced Study. For the prompt publication of short articles there is available the Proceedings of the National Academy of Sciences. There are in addition certain facilities to be found in the annual publications of learned societies (such as the American Academy of Arts and Sciences) and of higher institutions of learning (such as the Rice Institute Pamphlets), etc. Thus far, however, the commercial publishing houses of the country have not contributed much towards the publication of important advanced mathematical texts. In this respect they suffer by comparison with progressive European publishers, who take pride in the publication of significant mathematical books. The University Presses of the country have partly made up for this lack.

In addition to our regular meetings, the Colloquium Lectures, the annual Gibbs Lecture and the Visiting Lectures of the society provide important means for direct scientific interchanges among mathematicians. The coming International Congress of Mathematicians to be held at Cambridge in September, 1940, will present still other opportunities of this kind. In fact, the facilities for mathematicians to meet intimately with their colleagues at sister institutions are increasing constantly. The importance of such facilities in speeding up mathematical progress has long been recognized in European mathematical centers.

Then there is always the arduous administrative work of the society, carried on unselfishly by its officers and especially by its present secretary, Dean R. G. D. Richardson, true successor of Frank Nelson Cole. The way in which this work has been carefully and devotedly done without any paid officer has helped to unite the society more than anything else.

All in all, then, our American mathematical situation is about as favorable as can be hoped for on this very troubled planet. Our one real danger perhaps concerns the general standard of achievement. It is not enough for those who go into the rank and file of our colleges to devote themselves to a useful academic routine; they have a duty to live up to their highest mathematical potentialities and to awaken a

deep mathematical interest in their students. It is not enough for the exceptional man, whose early work has led to a professional recognition, to take thenceforth an easy-going attitude; such a man should continue with the devotion of a leader in a great cause. Furthermore, we ought all to provide our share of first-rate elementary teaching, by which we justify our privileged positions in immediate practical terms. If we do these things, mathematics in America will rise to still greater heights and there will appear among us mathematical figures comparable to the greatest in the past.

OBITUARY

GUY N. COLLINS

GUY N. COLLINS, Principal Botanist in the Division of Cereal Crops and Diseases of the Bureau of Plant Industry in the U. S. Department of Agriculture, died on August 14, 1938, of endocarditis at his home at Lanham, Maryland. Mr. Collins was born at Mertensia, N. Y., on August 9, 1872. He attended Syracuse University, but terminated his college career as an undergraduate in 1895 to join a survey expedition to Liberia organized by Dr. O. F. Cook for the New York Colonization Society. While in Africa he indulged his interest and perfected his skill in photography with the result that all his travels and most of his work are photographically recorded. Pursuing this interest he later designed and patented the Naturalist's Camera, which made it possible for the first time expeditiously to photograph objects natural size in the field.

His plates of fresh specimens of fruits, flowers and sections of plants, reproduced full size, did much to stimulate this method of recording.

Following the vicissitudes of life in the tropical rain forests of the West Coast of Africa, in the days before the discovery of the relation of mosquitoes to malaria and yellow fever, he returned to the United States and spent a few months (in 1898) as a free lance botanical collector on the Florida Keys.

Shortly after the close of the Spanish-American War he joined the staff of the Office of Botanical Investigations in the U. S. Department of Agriculture as Assistant Botanist, and in company with Dr. O. F. Cook explored the newly acquired island of Puerto Rico. Their expedition resulted in the publication by the Smithsonian Institution of the still standard treatise entitled "Economic Plants of Porto Rico." At this time also Mr. Collins wrote "The Mango in Porto Rico," probably the handsomest bulletin ever issued by the Bureau of Plant Industry.

Returning from Puerto Rico he entered the Seed Laboratory of the Division of Botany and there devised much of the apparatus used for subdividing large lots of seeds into samples for germination and purity tests. He never lost interest in the statistical problems of seed testing and the means for determining the probable quality of a large lot of seed from the analysis of small subsamples. This interest was manifested many years later by the publication of a paper on "The Application of Statistical Methods to Seed Testing."

In 1901 he published the bulletin "Seeds of Commercial Salt Bushes." In this undertaking full use was made of his skill in photography, and the plates of seeds in that bulletin have never been equalled in excellence of detail.

Many expeditions to the American Tropics followed his trip to Puerto Rico, and from one of these came the introduction of the Guatemalan "hard-shelled" avocado, which has been utilized extensively in developing the commercial varieties of this fruit grown in Florida.

While on another of these expeditions to Southern Mexico, accompanied by C. B. Doyle, he collected at Acala the variety of cotton now grown extensively under that name in the Southwest. This variety is known for its superlative qualities and far exceeds in merit any other cotton of the Upland type.

On all these expeditions to the American Tropics Mr. Collins lived on and close to Indian corn, and it is not surprising that the diversity of this magnificent grass captured his fancy. Soon his own garden at Lanham was crowded with a collection of tropical maize, and he was not slow to recognize the usefulness of this plant in testing and extending Mendel's rediscovered laws of inheritance.

His first contribution to the literature of maize was printed in 1909, at which time he was Assistant Botanist in the Office of Bionomic Investigations of Tropical and Subtropical Plants in the Bureau of Plant Industry. From that time on, though his official title and administrative position went through many changes, his time was devoted to a study of inheritance in maize and to the application to that study of biometrical methods, without which, he was convinced, no adequate conclusions could be reached. The numerous papers on inheritance in maize, published chiefly by the U. S. Department of Agriculture, constitute a permanent record of his achievements in research.

Mr. Collins was among that early group of investigators whose work provided the foundation on which rests the present popular system of producing commercial corn crops from hybrid seed. However, his interest in the commercial utilization of hybrid seed was

limited to the methods of determining the best combinations of strains and to the technique of producing such combinations.

The study of inheritance in maize led quite naturally to an interest in the origin of this crop and an interest in the American Indians who developed it. Consequently his articles on the phylogeny, agricultural history and origin of maize are definite contributions to this subject, ranking equally in importance to his contributions to maize heredity.

His insistence on the use of biometry not only on his own data but on those of his associates in the Bureau of Plant Industry compelled him to contribute much of his time to other investigators, at that time feeling their way through the labyrinth of statistical methods. In this manner he made contributions to much of the research of his colleagues. His was the first division in the Department of Agriculture to utilize the now common Hollerith tabulating machines.

Mr. Collins was devoted to the billiard table with its fascinating geometrical and psychological problems and was an ardent baseball fan. Confined to his home by his last illness he undertook with the aid of the radio to determine whether left-handed pitchers were more effective against left-handed batters than against right-handed batters, as is claimed by most team managers. This study was not completed.

Mr. Collins was highly regarded by his colleagues for his absolute honesty and for the objectivity with which he approached all problems whether of a personal or scientific nature. He was always patient and tolerant, particularly with younger workers to whose projects he was ever ready to contribute both advice and assistance.

To his staff he was a father confessor whose ready sympathy and understanding lightened many a burden.

In his death biological science has lost a great spirit, always fired with enthusiastic curiosity on scientific questions and tempered with a reasonableness that can come only with the highest intellectual development.

Mr. Collins is survived by his widow, Christine Collins, and two sons, George Briggs Collins, Assistant Professor of Physics at the University of Notre Dame, South Bend, Indiana, and Perez Hathaway Collins, of the Engineering Department of the Dye Works Division of the du Pont Company, Wilmington, Delaware.

J. H. KEMPTON

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

RECENT DEATHS AND MEMORIALS

EDWARD MURRAY EAST, professor of genetics at Harvard University, died on November 9 at the age of fifty-nine years.

JOHN HENRY NEFF, professor of urology at the University of Virginia, died by suicide on November 9. He was fifty-one years old.

THE following deaths are noted in *Nature:* Sir John Griffith, president of the Institution of Civil Engineers in 1919, on October 21, aged ninety years; George Jennison, formerly owner and principal curator of the Belle Vue Zoological Gardens, Manchester, on October 21, aged sixty-six years; Colonel J. Clibborn, formerly principal of the Thomason Engineering College, Rorkee, known for his work in connection with irrigation in northern India, on October 31, aged ninety years.

IN honor of the late Dr. C. H. Eckles, chairman of the department of dairy husbandry at the Missouri College of Agriculture from 1901 to 1919, who died on February 13, 1933, the Board of Curators of the university has announced that the new dairy husbandry building will be named Eckles Hall.

SCIENTIFIC EVENTS

UNITED STATES STANDARDS IN ARGENTINA

THE Board of Directors of the American Standards Association has taken favorable action on a proposal that a permanent staff representative be stationed in Buenos Aires for the purpose of promoting American standards and other standards now in use by American industry. The decision of the board to take this action was based largely on the recommendations of a group of manufacturing concerns, trade associations and technical societies that met last June to discuss the need of a better knowledge of American industrial standards in South America. The fact that British, German and other interests have for some time been active in encouraging adoption of their standards had already brought forth suggestions from the U. S. Chamber of Commerce at Buenos Aires that American interests should also be represented.

Argentina, primarily an agricultural country, is the market for many American-made products. With the exception of Canada, it provides the leading outlet for motor trucks. It is the seat of several large American-owned meat-packing plants. North American oil companies have an interest in Argentina's petroleum business. Such firms as Goodyear, Firestone, Michelin and Dunlop manufacture tires in the country; du Pont has a rayon factory there and is also bidding for a share of the country's chemical business. The International Telephone and Telegraph Company counts Argentine business as its largest single foreign invest-

ment. In this situation a better understanding of American industrial standards has been felt to be an important factor in our future business relations with the country.

The action taken by the A. S. A. Board is contingent upon the guarantee of sufficient funds to support the work by the concerns interested in the project. A committee, consisting of L. J. Briggs, director, National Bureau of Standards; C. L. Collens, president, Reliance Electric and Engineering Company; Howard Coonley, chairman of board, Walworth Company, and R. E. Zimmerman, vice-president, U. S. Steel Corporation, has been appointed to draw up a possible budget and to determine definitely whether and from what sources financial support may be forthcoming. This committee will also, with the advice and collaboration of the National Foreign Trade Council and of those American firms participating in the financial program, assist in the selection of the proposed representative. This representative, who will be stationed at Buenos Aires, will undoubtedly look for considerable supervision and guidance in his work to the American Chamber of Commerce at Buenos Aires, which has expressed itself as exceedingly interested in the project.

THE ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE fifty-ninth annual meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies Building in New York City from December 5 to 9. It will present the latest developments in the fields of machine tools, steam power, aeronautics, management, safety, metals, fuels, instruments, textiles, hydraulics, lubrication, railroads, research and ordnance.

Engineers from all parts of the world will attend the meeting to present the results of their work in all phases of mechanical engineering, with particular emphasis on high speed, high pressure, high efficiency and high temperature. For each engineer who speaks, it is expected that there will be twenty-five others in attendance.

During the week, delegates from the seventy-one local sections of the society in the United States and Canada will meet to discuss ways and means of increasing the usefulness of the society, which has now 15,000 members, to the individual member and to his community. A conference will be held for the purpose of correlating the activities of the divisions so as better to promote the art and science of mechanical engineering as a whole. The society at present is made up of seventeen divisions: Aeronautics, Applied Mechanics, Fuels, Graphic Arts, Heat Transfer, Hydraulics, Iron and Steel, Machine Shop Practice, Management, Materials Handling, Oil and Gas Power, Petroleum, Power, Process Industries, Railroad, Textile and Wood Industries.

Besides the technical sessions, there will be a business meeting on Monday afternoon, December 5, and several luncheons and dinners. The chief social events are: Honors Night on Tuesday evening, December 6, when awards and medals will be presented, and the annual dinner on Wednesday evening, December 7.

THE MATHEMATICAL ASSOCIATION OF AMERICA

THE twenty-third annual meeting of the Mathematical Association of America will be held at Richmond and Williamsburg, Virginia, from Tuesday to Saturday, December 27–31, in conjunction with the meeting of the American Association for the Advancement of Science, the American Mathematical Society and the National Council of Teachers of Mathematics.

The association will meet jointly with Sections A and E of the American Association for the Advancement of Science and the society on Wednesday morning in Richmond and will hold a joint session with the National Council at Williamsburg on Friday afternoon and a separate session on Saturday morning, when the annual business meeting will be held. The Program Committee is planning three addresses for the Saturday morning session.

The American Mathematical Society will hold sessions on Wednesday morning in Richmond and on Wednesday afternoon through Friday morning in Williamsburg; on Thursday afternoon President R. L. Moore will deliver his retiring address, "On Certain Abstract Spaces." The National Council will hold on Friday morning a section on arithmetic and a secondary section on school mathematics; at the joint session on Friday afternoon addresses on teacher training will be given by Professors A. A. Bennett, F. L. Wren and R. L. Morton.

On Tuesday evening, in Richmond, Dean G. D. Birkhoff, of Harvard University, will deliver his address as retiring president of the American Association for the Advancement of Science on "Intuition, Reason and Faith in Science." This is the opening meeting of the association.

In the Broadcasting Studio of the Mosque, Richmond, at 9:30 A.M., on Wednesday, Professor W. D. Cairns, of Oberlin College, will deliver his retiring address as vice-president of the American Association for the Advancement of Science and chairman of Section A before a joint session of Sections A and E, the American Mathematical Society and the Mathematical Association. His subject will be "Seismology from a Mathematical Viewpoint." At 10:45 Professor H. A. Rademacher, of the University of Pennsylvania, will make an address on "Fourier Expansions

of Modular Functions and Theorems on Partitions" at a joint session of Section A, the Mathematical Society and the Mathematical Association. At the Mosque at 11:00 A.M., on Wednesday, Professor R. C. Archibald, of Brown University, will deliver his retiring address as vice-president and chairman of Section L. He will speak on "Mathematicians, and Poetry and Drama."

AWARD OF THE PENROSE MEDAL TO PROFESSOR LAWSON

THE Penrose Medal, the highest honor of the Geological Society of America, has been awarded to Dr. Andrew Cowper Lawson, professor emeritus of geology and mineralogy at the University of California, "for eminent research in pure geology, and outstanding original contributions and achievements which mark a decided advance in the science of geology."

Dr. Lawson, authority on earthquake phenomena and continental border movements, is the tenth recipient of the medal since its founding in 1927 by the late Dr. R. A. F. Penrose, Jr., of Philadelphia. Presentation will be made at a dinner at the Waldorf-Astoria Hotel, New York City, on December 30 during the semi-centennial meeting of the society.

Engaged in many different phases of research in geology since 1882, Dr. Lawson has studied and published reports on numerous regions of the United States and Canada. After the great California earthquake in 1906 he organized and directed investigations in seismology, advancing the science of predicting earthquakes. He has recently devoted much attention to fundamental theories concerning the nature and process of certain types of earth movements, and is author of a series of papers on the applications and implication of the theory of isostasy, a subject involving the theoretical condition of equilibrium which the earth's surface assumes under gravitation. He has been on the faculty of the University of California for forty-eight years.

Dr. Lawson was born in Anstruther, Scotland, on July 25, 1861. He was graduated from the University of Toronto in 1883. He took the master of arts degree at Toronto in 1885, and the doctor's degree at the Johns Hopkins University in 1888. Harvard University conferred the honorary degree of science upon him in 1936, the University of Toronto having similarly honored him in 1923. He received the honorary degree of doctor of laws from the University of California in 1934.

He became assistant professor of mineralogy and geology at the University of California in 1890, having been on the Canadian Geological Survey eight years. In 1892 he was named associate professor, and in 1899 full professor, continuing until his retirement from active duty in 1928. He was dean of the College of Mining from 1914 to 1918. Besides being chairman of the California State Earthquake Committee in 1906, he was a member of the U. S. Assay Commission in 1916; chairman of the Division of Geology and Geography of the National Research Council in 1923-24, and delegate to the International Geological Congress in 1888 in London, 1897 in St. Petersburg, 1913 in Toronto and 1928 in Madrid.

Dr. Lawson was president of the Geological Society in 1926, vice-president in 1908, chairman of the Cordilleran Section from 1906 to 1912 and secretary of the same section from 1899 to 1906. He was president of the Seismological Society of America in 1909. He is also a member of the American Association for the Advancement of Science, the American Institute of Mining and Metallurgical Engineers, the American Academy of Arts and Sciences, the American Philosophical Society and the National Academy of Sciences.

The award committee, in addition to Dr. Vaughan, was composed of Professors Nevin M. Fenneman, of the University of Cincinnati; Douglas Johnson, of Columbia University; Donald H. McLaughlin, of Harvard University; Adolph Knopf, of Yale University; John P. Buwalda, of the California Institute of Technology, and James Gilluly, of the University of California at Los Angeles.

Previous recipients of the medal have been: Thomas C. Chamberlin, 1927; Jakob J. Sederholm, 1928; Francois A. A. Lacroix, 1930; William M. Davis, 1931; Edward O. Ulrich, 1932; Waldemar Lindgren, 1933; Charles Schuchert, 1934; Reginald A. Daly, 1935, and Arthur P. Coleman, 1936. No medal was awarded in 1929 and 1937.

SCIENTIFIC NOTES AND NEWS

THE Nobel prize in physics has been awarded to Professor Enrico Fermi, of the University of Rome, "in recognition of his discovery of new elementary radioactive substances engendered by irradiation of neutrons." It is announced that Nobel prizes for physiology and medicine and for chemistry will not be awarded this year.

THE following awards of medals have been made by the President and Council of the Royal Society, London: The Copley Medal to Professor Niels Bohr, For.Mem.R.S., in recognition of his distinguished work in theoretical physics and particularly in the development of the quantum theory of atomic structure. The Rumford Medal, as announced in SCIENCE

last week, to Professor R. W. Wood, For.Mem.R.S., in recognition of his distinguished work and discoveries in many branches of physical optics. The Davy Medal to Professor G. Barger, F.R.S., in recognition of his distinguished researches on alkaloids and other natural products. The Darwin Medal to Professor F. O. Bower, F.R.S., in recognition of his work of acknowledged distinction in the field in which Darwin himself labored. The Hughes Medal, awarded jointly to Dr. J. D. Cockcroft and Dr. E. T. S. Walton, in recognition of their discovery that nuclei could be disintegrated by artificially produced bombarding particles.

DR. IRVIN ABELL, of Louisville, president of the American Medical Association, received on November 5 the Laetare Medal, awarded annually by the University of Notre Dame to an outstanding Catholic layman.

THE Norman Medal of the American Society of Civil Engineers has been awarded to Professor Hunter Rouse, of the California Institute of Technology, for his work on the mechanics of fluid turbulence.

ON the occasion of the fiftieth anniversary of Goucher College, Baltimore, the degree of doctor of laws was conferred on Dr. Margaret Reed Lewis, of the department of embryology of the Carnegie Institution at the Johns Hopkins University; on Dr. Madge Thurlow Macklin, of the Medical School of the University of Western Ontario, and on Dr. Florence Barbara Seibert, of the Henry Phipps Institute of the University of Pennsylvania.

DR. C. L. HUSKINS, professor of genetics at McGill University, has been granted leave of absence for the autumn term to enable him to become visiting professor of botany at the University of California. He will take over the courses in cytology during the absence of Professor T. H. Goodspeed, now directing a botanical expedition into South America. Dr. R. M. Love, of the Cereal Division, Central Experimental Farm, Ottawa, has been appointed sessional lecturer in genetics at McGill University. Dr. Sheldon C. Reed has been made acting chairman of the department.

DR. PETER GRAY, lecturer in embryology at the University of Edinburgh, has been appointed associate professor of biology at the University of Pittsburgh. He will take up the work at the beginning of the next semester.

FOLLOWING a year spent at the University of Oxford on a Guggenheim fellowship, Dr. Lawrence Olin Brockway has been appointed assistant professor of chemistry at the University of Michigan.

DR. HARRY R. DESILVA, lecturer in psychology at Harvard University, has been appointed research associate in psychology at Yale University. He will have charge of a program of Automobile Driver Research in the Institute of Human Relations. Research on drivers will be carried out by a staff in cooperation with neighboring motor vehicle departments. The work is made possible by a grant to Yale University from the recently established Esso Safety Foundation.

DR. G. L. FREEMAN has been promoted to an associate professorship of psychology at Northwestern University. James Egan and Louis Krasno have received research appointments in the Laboratory of Psychophysiology.

DR. H. S. W. MASSEY has been appointed from January 1, 1939, to the Goldsmid chair of mathematics tenable at University College, London. Since 1933 he has been lecturer in mathematical physics at Queen's University, Belfast.

DR. ROBERT K. ENDERS, of the Edward Martin Biological Laboratory of Swarthmore College, has been promoted to an associate professorship and has been granted leave for the year 1938–1939. He will be stationed at Swarthmore College, where he will continue, as biologist of the Bureau of Biological Survey, to work on the reproductive cycle of the mink. This project is supported by a grant from the Bankhead-Jones Special Research Fund.

CLARENCE BEAMAN SMITH, assistant director of extension work and chief of the Division of Cooperative Extension of the U. S. Department of Agriculture, retired on October 31. He had been in the department for forty-two years, thirty of which were in connection with extension work.

JAMES R. KILLIAN, JR., editor of the *Technology Review*, has been appointed to fill the newly established post of executive assistant to the president of the Massachusetts Institute of Technology, Dr. Karl T. Compton. Mr. Killian will participate in the administration of the institute and will take over some of the responsibilities which have been carried by Vice-president Vannevar Bush, who on the first of the year becomes president of the Carnegie Institution of Washington. He will also be chairman of the Board of Publications of the Technology Press. Mr. Killian was for three years secretary of the board of publications of the American Chemical Society.

THE Lord President of the Council of the British Department of Scientific and Industrial Research has appointed Dr. G. Stafford Whitby, at present director of the division of chemistry of the National Research Council, Canada, formerly professor of chemistry at McGill University, to be director of the Chemical Research Laboratory, Teddington, in succession to Sir Gilbert Morgan, who retired on September 10. Dr. Whitby is expected to take up the work early in 1939.

A GRANT of $600 has been awarded to Dr. Frank J. Studer, of the department of physics at Union College, by the American Institute of Electrical Engineers for fundamental research on the physics of resistance welding.

DR. ROBERT L. STARKEY, of the New Jersey Agricultural Experiment Station, has returned after a year's work in the laboratory of Professor Kluyver at Delft, Holland.

J. C. HENING, associate in dairy research at the New York State Experiment Station at Geneva, has returned from a six-months' leave, during which he worked at the Dairy Research Institute of the University of Reading, England.

PROFESSOR ALBERT EINSTEIN will be chairman of the Advisory Committee on Science of the New York World's Fair, which will cooperate in preparing a central exhibit of science. Other members of the committee are: Dr. Robert Chambers, of New York University, zoology; Dr. Karl T. Compton, president of Massachusetts Institute of Technology, physics; Gano Dunn, of J. G. White Engineering Corporation and president of Cooper Union, industrial research; Dr. Frank B. Jewett, vice-president of the American Telephone and Telegraph Company, industry; Waldemar Kaempffert, *The New York Times*, the public; Paul B. Mann, Evander Childs High School, New York City, children's interests; Professor R. H. McKee, Columbia University, chemistry; Charles F. Roth, manager of the Grand Central Palace, New York City, industrial exposition technique; Professor Edmund W. Sinnott, Columbia University, botany, and Dr. Gerald Wendt, director of science at the fair, who will act as secretary to the committee.

PROFESSOR NIELS BOHR, of the University of Copenhagen, will lecture at the Institute for Advanced Study at Princeton. He plans to give one formal lecture a week from January 17 to May 1, under the title, "Elements and Principles of Atomic Theory."

DR. RAYMOND PEARL, of the School of Hygiene and Public Health of the Johns Hopkins University, was in residence at Indiana University from September 27 to November 15. He conducted a number of seminars and gave a series of five public lectures on "Man the Animal." This was the first series of lectures under the Patten Foundation established in 1936.

DR. ARNO B. LUCKHARDT, professor of physiology at the University of Chicago, gave the annual N. W. Jones lectures on November 2, 3 and 4, at the University of Oregon Medical School. His subjects were: "Dr. Wm. Beaumont and the Beaumont Memorabilia of the University of Chicago"; "Academic or Unsuccessful Research"; and "A Neglected Chapter in Anatomic Illustration and Instruction."

DR. GEORGE SARTON, lecturer at Harvard University on the history of science and editor of *Isis* and *Osiris*, journals of the history of science, lectured on November 9 on "The Function of Academies—Past and Present," before the American Academy of Arts and Sciences, Boston.

DR. WENDELL MEREDITH STANLEY, of the department of animal and plant pathology of the Rockefeller Institute for Medical Research at Princeton, N. J., gave on November 14 an address before the New York Academy of Sciences entitled "The Nature of Viruses."

DR. K. LARK-HOROVITZ writes: "In my recent review on new text-books in physics (SCIENCE, October 14, page 354), I discussed the excellent new text of R. A. Millikan and collaborators. Unfortunately I quoted the book as Millikan and Roller. I hasten to correct this mistake, which has been pointed out to me by several colleagues—the actual authors of this book are R. A. Millikan, D. Roller and E. C. Watson."

A PRESS dispatch from San Francisco, Calif., dated November 10, reports that California voters administered an overwhelming defeat to a state proposition which would have prohibited the use of impounded animals for medical purposes. With most of the precincts counted, the vote was 560,795 favoring the proposition, and 1,164,097 against it.

DR. ELLIOTT C. CUTLER, Moseley professor of surgery, Harvard Medical School, and chairman of the American Medical Association Committee for Protection of Medical Research, writes to Science Service: "The defeat of the so-called humane pound initiative measure in California will encourage all scientific bodies, defenders of biological research, and doctors everywhere to continue their investigations for the betterment of the health of the American people. The defeat on this bill is a clear indication that the public as a whole believes in defending the frontiers of knowledge and in training doctors in technical methods in surgery through the use of animals. It is to be hoped that the recent defeat to the misguided sentimentalists in their attempt to embarrass and hinder medical research will lead people to appreciate that the promise of future improvements in public health matters and the discoveries which will better their welfare will largely depend upon the freedom with which scientists may conduct investigations."

THE National Research Council has subscribed to a table in the Stazione Zoologica di Napoli. Biologists desiring to avail themselves of the use of this table in the near future should write to the Division of Biology and Agriculture, National Research Council, Washington, D. C. The award of the table will be in the hands of a committee of the division, consisting

of the representative to the Division from the American Society of Zoologists, chairman, the president of the American Society of Zoologists, the president of the Botanical Society of America and the chairman of the Division of Biology and Agriculture, National Research Council, *ex officio*.

THE College of Medicine of the State University of Iowa announces a gift of $22,500 from the John and Mary R. Markle Foundation, to be spent over a two-year period; $12,500 of the fund will provide for a continuation of the research on inflammatory conditions of the eye in the department of ophthalmology under Dr. C. S. O'Brien, and the remainder will be used to continue the research program on blood clotting and the bleeding tendency in the department of pathology under Dr. H. P. Smith.

THE Committee on Scientific Research of the American Medical Association has recently awarded grants to Dr. Rucker Cleveland, of the department of anatomy, Vanderbilt University School of Medicine, for research on the cytology of the endometrium; to Dr. A. R. Buchanan, professor of anatomy, University of Mississippi Medical School, to be used for research on the vestibular mechanism in monkeys; to Dr. E. Spiegel, of the School of Medicine of Temple University, Philadelphia, for work on "physicochemical factors influencing the excitability of the central nervous system"; to H. D. West, associate professor of biochemistry at Meharry Medical College, Nashville, Tenn., for the continuation of his work on the synthesis of dl-threonine; to Dr. Charles F. Code, of the department of physiology of the University of Minnesota, for his work upon the histamine content of blood in normal and certain abnormal conditions; to Dr. A. Emge, of Stanford University School of Medicine, for further studies on the relation of sex hormones to tumor growth; to H. E. Carter, assistant professor of biochemistry at the University of Illinois, for the study of betaines of aminohydroxyl acids, and to Dr. Alexander Levy, for experimental work in the field of chest surgery, to be carried on in the department of surgery of the Medical School of the University of Oregon.

APPLICATIONS for the position of principal industrial toxicologist (organic compounds) in the U. S. Public Health Service, at a salary of $5,600 a year, must be on file with the U. S. Civil Service Commission at Washington, D. C., on November 28.

THE School of Mathematics of the Institute for Advanced Study each year allocates a small number of stipends to gifted young mathematicians and mathematical physicists for the purpose of enabling them to broaden their scientific outlook and to work on their research programs at Princeton in contact with the members of the institute and university faculties. Only such candidates will be considered as have already given evidence of ability in independent research comparable at least with that expected for the degree of doctor of philosophy. Applications for the academic year 1939–40 should be filed before February 1, 1939. Blanks for this purpose may be obtained from the School of Mathematics, The Institute for Advanced Study, Fine Hall, Princeton, N. J.

ANNOUNCEMENT has been made by the Finney-Howell Research Foundation, Inc., that all applications for fellowships for next year must be filed in the office of the foundation, 1211 Cathedral Street, Baltimore, Md., by January 1. Applications received after that date can not be considered for 1939 awards, which will be made on the first of March. This foundation was provided for in the will of the late Dr. George Walker, of Baltimore, for the support of "research work into the cause or causes and the treatment of cancer." The will directed that the surplus income from the assets of the foundation together with the principal sum should be expended within a period of ten years to support a number of fellowships in cancer research, each with an annual stipend of two thousand dollars, "in such universities, laboratories and other institutions, wherever situated, as may be approved by the Board of Directors." Ten such fellowships were awarded in 1938. Fellowships carrying an annual stipend of $2,000 are awarded for the period of one year, with the possibility of renewal up to three years; when deemed wise by the board of directors, special grants of limited sums may be made to support the work carried on under a fellowship.

A SIXTEEN unit display entitled "The March of Life" will make up the exhibit of the University of California Medical School at the Golden Gate International Exposition in 1939. The presentation will show what medicine and surgery have accomplished since the time of Hippocrates and, in addition, demonstrate the services rendered by the university's medical center to its own students.

DISCUSSION

A MEASURE OF THE FLIGHT CAPACITY OF GRASSHOPPERS

THAT grasshoppers have a most effective means of relieving congestion in one quarter and contributing to it in another is indicated by the results of a recent study conducted by the North Dakota Agricultural Experiment Station.

For some years it has been apparent that localized

outbreaks of grasshoppers, when inadequately checked by control agencies, tend to spread rather rapidly over wide areas. In other words, the problem of controlling grasshoppers may change from that of a few spotted or localized outbreaks to a statewide, regional or international problem in the course of a few years, as is the case in the present grasshopper situation of the Great Plains area.

To secure definite information on the speed and direction of grasshopper dispersal upwards of 100,000 grasshoppers were sprayed with a fast-drying red lacquer and released on July 17 a few miles west of LaMoure in southeastern North Dakota. A cage of the marked grasshoppers kept under observation showed no ill effects of the treatment and appeared to behave similarly to unmarked individuals. Two days following the release, four of the marked specimens (three *Melanoplus mexicanus* and one *Melanoplus differentialis*) were recovered near Nortonville at a point 20 miles northwest of the place where the grasshoppers were released. Subsequent recoveries included only the more migratory grasshopper, *M. mexicanus* (see Table 1).

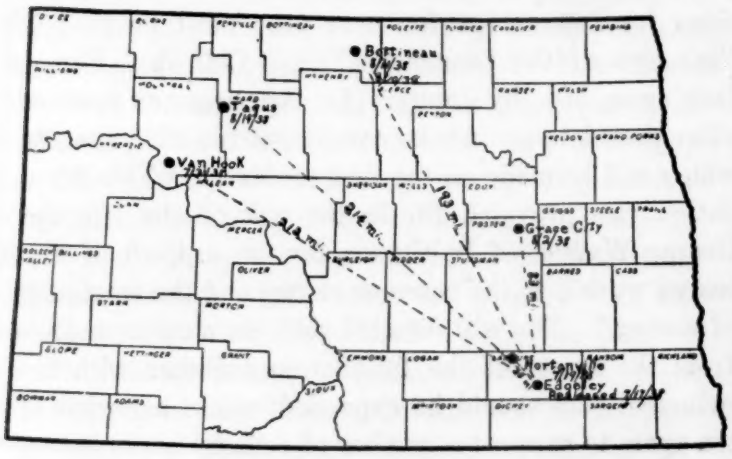

FIG. 1. Flight dispersal of grasshoppers.

TABLE 1

Number of specimens	Date and place of capture	Distance traveled	Number of days	Name of collector
		miles		
1	July 31—Van Hook	215	14	Mrs. John Murray
1	Aug. 2—Grace City	86	16	Orrin Topp
2	" 10—Bottineau	193	24	Mrs. W. D. Williams
1	" 11—Bottineau	193	25	V. H. Florell
1	" 14—Tagus	214	28	Jean Engen

The few recoveries verified to date have ranged from north to northwest from the point of release. A possible explanation of this may be that winds from the south and southeast, being warmer than those from the other directions, were more effective in promoting sustained flight of the insects. U. S. Weather Bureau records reveal that for 18 days of the 29-day period, beginning on July 17, winds from the south and southeast prevailed with an average daily maximum temperature of 88.9° F. For the remaining 11 days, which included 7 in July and 4 in August, the winds from the north and northwest prevailed with an average daily maximum temperature of 79° F.—a difference of 9.9° F. lower than the warmer winds from the south. The average velocity of the southern winds averaged 7.04 miles per hour, while those from the northerly directions averaged 8.1 miles. The heavy flights were generally observed to be traveling with the prevailing winds from the south.

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AUTHORITY CITATIONS AGAIN

THE discussion of authority citations by Donald Culross Peattie and Arthur Paul Jacot is very timely, for it appears that in some instances this device augments the confusion instead of diminishing it. This is particularly true if the original authorities did not publish their descriptions. In such cases the names get into circulation by exchange of material, and their ultimate publication is by a different author. Thus the specific names of Solander first appeared in Dillwyn's catalogue, and when Solander's name is quoted, as it frequently is, it gives no clue to the location of the original description in print.

Often the real meaning of a generic name is fixed, not by the original description, but by the type designation, which not infrequently is by a later author, in which case it is impossible to refer to the description and designation both without having recourse to a double citation, undesirable and awkward as such a practice may be.

My own feeling is that what is needed is a periodical that would perform the functions of a biological nomenclator, in which might be published references to descriptions, type designations, synonymies, etc., and to which reference might be made in lieu of to an "authority." For lack of such a medium students have been compelled to publish material of this sort in divers scattered places, where it is inappropriate, difficult of access and takes up space that increases the cost of publication.

It is to be hoped that biologists will succeed in devising some way by which material of purely nomenclatorial interest and significance can be concentrated in one place, where it will be available when needed.

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A REVERSED CAT

AN adult female cat purchased for student use in comparative anatomy was found, upon dissection, to have its internal organs completely reversed in every detail studied. Lungs, kidneys, veins and arteries and all parts of the digestive tract were normal in size and shape but so situated that descriptions for the left side fitted the right perfectly and *vice versa*. The aortic loop arose from the larger right ventricle and arched to the right. Other parts of the heart and its vessels were changed accordingly. The animal, although heavily infested with tapeworms and undernourished, appeared sound and normal in every other respect. No reference to an entirely reversed cat has been found in the literature. It may have been one of a pair of identical twins, since it is supposed that the occurrence of the phenomenon of reversal in man and other mammals is due to splitting of the embryo at some early stage.

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ELLIPTICAL ERYTHROCYTES

SINCE Gulliver[1] reported his measurements of the red blood corpuscles of many species (including the sloth) writers in text-books and special treatises have said as Jordan[2] said lately: ". . . among mammals the shape of the red blood corpuscles is uniformly that of a circular biconcave disk, except in the Camelidae, where these elements have an elliptical shape."

So far as I can learn no one questioned that statement until in a recent article Schartum-Hansen[3] included the sloth among mammals having elliptical erythrocytes. This note is written in the hope that some one who is in a position to do so will tell us who is right about the erythrocytes of the sloth.

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M(ANILLE) IDE, THE DISCOVERER OF "BIOS"

IN connection with attendance at the 16th International Physiological Congress this past summer in Zurich, I had an opportunity to visit the University of Louvain, in Belgium, where "bios" investigations originated about 1900. I hoped to be able to find out more about Wildiers (deceased in 1906), under whose name the first article on this subject was published, and who is credited by some as being the first discoverer of a vitamin. After careful questioning, both of Dr. Ide (ēd′ĕ), emeritus professor of pharmacology, and his successor, Professor André Simonart, I was fully convinced that I had found, still living, the discoverer of "bios" in the person of Professor M(anille) Ide.

E. Wildiers was an immature undergraduate medical student of comparatively mediocre attainments at the University of Louvain. He helped Dr. Ide with his research which culminated in the discovery of "bios," and was allowed by Dr. Ide to use the results of the research in a thesis which was submitted in a competition for a traveling fellowship. (Incidentally, he did not win the award.) Under these conditions Professor Ide's name could not appear on the publication. Wildiers continued his medical course, graduated and practiced medicine in Antwerp until the time of his death from scarlet fever in 1906. It is patent, especially in view of Dr. Ide's continued interest in this work from its inception to the present, that the credit for the discovery should go to him rather than to the immature and otherwise unproductive medical student who happened at the outset to help him with the experimental operations. Since 1901 Professor Ide has continued his investigations and has had the help of a number of medical students, among them two generations of R. Devloo (1906 and 1938).

Since his retirement (he is now 72) Professor Ide has continued his medical practice in the forenoons, but the afternoons find him working enthusiastically in his laboratory provided by the University of Louvain. He was without any laboratory assistance at the time of my visit, but was nevertheless actively carrying on the experimental work. He is enthusiastic in his work, a highly respected colleague in the University of Louvain and a most gracious and charming gentleman.

ROGER J. WILLIAMS
OREGON STATE COLLEGE

ABSTRACTS OF PAPERS PRESENTED AT THE CHAPEL HILL MEETING OF THE NATIONAL ACADEMY OF SCIENCES. II

Later evidence concerning meteoritic origin of Carolina "bays": W. F. PROUTY (introduced by Edward W. Berry). The meteoric theory of Melton and Schriever as modified by Prouty and MacCarthy is supported by recent magnetometer surveys and other field observations. A grid survey of a large area near Syracuse, South Carolina, which contains a number of well-spaced bays shows that there is a spot magnetic high associated with each of

[1] George Gulliver, *Proc. Zool. Soc. London*, p. 474, 1875.
[2] H. E. Jordan, "Downey's Handbook of Hematology," Hoeber, p. 840, 1938.
[3] H. Schartum-Hansen, *Acta Medica Scandinavica*, Vol. 86: fasc. II, p. 348, 1935.

the medium sized to large bays and that there is an absence of well-defined spot highs in areas away from the influence of the bays. The distribution of bays is restricted geographically, but in areas in which they occur, there seems to be no relationship to topography or rock character. Bays are elliptical with definite orientation. Sinks are irregular in shape and orientation. In soluble rock areas some bays have been modified by solution; such "bay-sinks" are sand-rimmed and distinguishable from sinks. Various "bay-sinks" suffer solution-elongation in various directions. The size of bays is independent of topography and solubility of rock. Movement of sands in bay areas is in general northeast as shown in present shape of bays and relation of sand-rims and dune areas to the bays. Section of two small, overlapping bays by the Intercoastal Waterway, near Myrtle Beach, furnishes a comparative study of sub-surface conditions in peat-filled elliptical bay area and peat-filled irregular shaped swamp areas nearby. Only under elliptical bay area is the underlying impervious clay layer penetrated by swamp water in sufficient quantity to dissolve the two fossil shell beds below. In conclusion it can be said that the latest investigations concerning the origin of "Carolina Bays" still further support the modified meteoric theory of their origin. All present known facts concerning the bays as observed by the writer seem to fit into this theory.

Changes in shape accompanying tetraploidy in cucurbit fruits: E. W. SINNOTT and A. F. BLAKESLEE. The most commonly observed differences between members of a polyploid series in plants have been the size differences resulting from the increased cell size which follows an increase in number of chromosome sets. That such changes may be accompanied by qualitative ones is shown by the marked differences in fruit shape between diploid races of various cucurbits and tetraploid races produced from them by treatment with colchicine. In every case the tetraploid fruit is distinctly shorter and wider than its corresponding diploid type. This result has been brought about both by changes in the shape of the early fruit primordium and in the relative growth rates of length and width during development. Races of *Cucurbita Pepo* and of *Lagenaria vulgaris* show this change, which is similar to that previously reported for capsule shape in Datura. Why an increase in chromosome number and cell size, with no alteration in genetic constitution, should produce such a specific change in form presents an important morphogenetic problem.

Observations on cilia of aquatic Phycomycetes: J. N. COUCH (introduced by A. F. Blakeslee). By staining with Loeffler's stain it has been found that the cilium of certain chytrids as *Rozella septigena* Cornu, *Woronina polycistis* Cornu, *Rhizophidium* (several species), *Cladochytrium replicatum* and other undescribed forms is composed of the long, rather thick, basal part which one can see by the usual staining technic and in addition a thin distal part which is invisible on the living spore and even when stained by the usual cilia stains. *Monoblepharis regignens* and *Allomyces moniliformis* have the same type of cilium. It seems highly probable that it is the thin part of the cilium that propels the spore, the thick part acting as a rudder. This kind of cilium is usually correlated with the absence of cellulose in the walls, but in certain undescribed forms the cell walls are of cellulose. Such chytrids with cellulose walls have given rise to no higher types but represent an offshoot from the main chytrid line. A second type of cilium occurs in *Rhizidiomyces apophysatus* and an undescribed genus which we have in culture on agar. Here the uniciliate spore lacks the thin distal part of the cilium, but frequently shows short, thin, lateral appendages. This kind of cilium is correlated with the presence of cellulose in the walls. It is unlikely that any of the existing higher Phycomycetes are derived from this line, for the higher forms all possess biciliate zoospores. A third type of ciliation has been recognized in the Phycomycetes. In an undescribed genus (an endo-parasite in the threads of an *Achlya*) closely related to the potato parasite, *Spongospora*, the spores have two cilia, one long, the other short, the short cilium having a long thin appendage. In *Olpidiopsis* sp. on *Achlya* a similar appendage has been found on one of the cilia, both of which are of about the same length. In *Pythium aphanidermatum* both cilia possess short, thin appendages, and in *Saprolegnia* and *Achlya* the thin appendages may usually be seen on one or both cilia. These studies indicate at least three lines of evolution in the aquatic Phycomycetes: (1) the chytrid-*Monoblepharis* line; (2) the *Rhizidiomyces* line; and (3) the biciliate line terminating in such forms as *Saprolegnia* and *Pythium*.

Interspecific grafts and mixtures among the Dictyosteliaceae: KENNETH B. RAPER (introduced by Charles Thom).

The structural organization of cellulose in cotton fibers: DONALD B. ANDERSON (introduced by Edmund W. Sinnott). The wall of the cotton fiber is composed of very minute thread-like strands of cellulose which anastomose freely with each other, forming a close-meshed network. In the oldest layer of the cell wall the cellulose strands are oriented in flat spirals, but in subsequent deposits the strands wind in steep spirals which frequently reverse their direction. The structural organization of the cellulose units in the wall does not appear to be influenced by environmental factors, but the rate at which the cellulose is deposited is subject to environmental control. It is possible, therefore, to control the apparent stratification in the wall of the fiber or to eliminate it completely by regulating the temperature and light during the period of cell wall thickening.

Downy mildew of tobacco: FREDERICK A. WOLF (introduced by R. A. Harper). Downy mildew of tobacco seedlings first appeared in Florida in 1921 and was eradicated only to reappear in 1931. The disease now involves nearly all tobacco-growing areas in the eastern United States and southern Canada. It is caused by *Peronospora taba-*

cina, a fungus having a sporangial stage by which it is disseminated and an oosporic stage by which it survives from one year to the next. Sporangia are formed at daybreak and are air-borne. Oospores constitute the inoculum for primary infections. Seed beds that occupy the sites of old infected beds are foci of infection. The severity and course of downy mildew are governed by weather conditions, cold, rainy, cloudy periods being especially favorable. Infection may be completely prevented or the disease may be checked, once it has begun, by use of benzol vapors. The minimal concentrations of benzol vapor that are effective have been determined. The modificatory influence of moisture, temperature, porosity of covers, amount of benzol applied, wind velocity and surface area of evaporators, upon treatment of seedlings with benzol vapors, has also been evaluated.

A saprophytic alga: W. C. COKER and LELAND SHANOR (introduced by E. D. Merrill). At two stations in northern Chatham County, N. C., in small runs receiving seepage from a burning sawdust pile, we have found a remarkable plant having the appearance of a higher green alga but with the nutrition of a saprophytic fungus. It has a body closely resembling that of *Stigeoclonium*, but is entirely without chlorophyll or any trace of an organ resembling a chloroplast. The cytoplasm is confined to an extremely thin layer under the wall, and each cell has a large conspicuous nucleus. The tip cells of the branches are extremely tenuous and end in a fine point, which is found to be viscid. These tip cells fall off easily and attach themselves by their points to objects in the water. Reversing their polarity, they soon develop into a much-branched plant reaching a length of about 1 cm and having exactly the appearance of a vigorous water mold. This vegetative propagation by the distal cells is the only method of multiplication which the plant has, so far as known. A complicated group of rhizoidal holdfasts is sent off from the basal cell and from several cells above it. The cell walls are not of cellulose, which fact still further complicates the situation. Several parasitic alga-like plants that have quite or nearly lost their chlorophyll are known, but, so far as the writers are aware, no strictly saprophytic species with the form of an alga has ever before been found.

Concerning the acquired resistance of renal epithelium to bichloride of mercury: WM. DEB. MACNIDER. If the kidney of the dog be slightly injured by uranium nitrate the epithelium of the convoluted tubules at which point this metal has a selective action repairs itself by the formation of a normal type of epithelial cell for this location of the nephron. Such cells have no resistance to a secondary injury by uranium. If the epithelium in this segment of the tubule be severely injured by uranium nitrate the epithelial repair process results in the formation of a flattened or syncytial type of cell which is atypical for this segment of the tubule. Associated with the development of this atypical type of cell formation there is acquired on the part of such cells in this segment of the tubule a marked degree of resistance against uranium nitrate. When bichloride of mercury is administered to an animal it selects for its major point of action in the kidney the specialized epithelium found in the convoluted tubule. When animals have received a severe renal injury for uranium nitrate so that an atypical type of epithelial repair has developed in the convoluted segment of the tubule the use of bichloride of mercury fails to show any evidence of injury to such epithelium in this segment of the nephron. The observation would indicate that injury to epithelial tissue by one type of toxic agent may protect an epithelial tissue of repair from a toxic agent of another type, provided the processes of repair to the epithelial tissue from the injurious agent has led to the formation of a change in the morphology of the epithelial cells in the location at which the different types of injurious agents exert their nephrotoxic action.

The growth-promoting properties of certain cystine derivatives: JAMES C. ANDREWS[1] (introduced by Wm. deB. MacNider). Although biological sulfur is chiefly introduced into the body as cystine and methionine and eliminated in the form of sulfates in the urine, the intermediate steps in this process are largely unknown. Sulfur metabolism may be arbitrarily divided into two main processes, both of which must take place before sulfates are produced: rupture of the bond between sulfur and carbon and oxidation of the sulfur to the hexavalent condition. One object of sulfur metabolism studies is to determine the order of these two reactions, the latter of which undoubtedly takes place in a series of steps. In judging the status of any given sulfur compound as an intermediary metabolite two criteria are used: ability of the compound to produce urinary sulfates and ability to substitute for cystine and methionine in supporting growth. The latter is by far the more exacting criterion since many inorganic sulfur compounds readily oxidize to sulfates but do not support growth when added to a diet deficient in cystine and methionine. In the present work, several derivatives of cystine were synthesized and administered to rats in a basal diet deficient in cystine and methionine. Cyclic derivatives such as cystine hydantoin and cystine phenyl hydantoin, the sulfonic acid oxidation products of the above hydantoins, a substitution product (dibenzoyl cystine) and a product of partial oxidation of cystine (cystine disulfoxide) were all used. The following results were obtained: Oxidation of the sulfur to the sulfonic acid group entirely inactivates the compound for growth support. Formation of hydantoin rings, with or without oxidation of the sulfur, inactivates the compound. If, in addition, a phenyl group is present, its further toxicity produces still more sharply declining growth curves. Dibenzoyl cystine, being capable of partial hydrolysis in the digestive tract, acts as a partial substitute, while cystine disulfoxide, which is very unstable and readily loses oxygen to form cystine, serves as a satisfactory substitute. This, however, by no means proves that cystine disulfoxide is necessarily an intermediary metabolite of cystine.

[1] In collaboration with James H. Jones, University of Pennsylvania, and Kathleen C. Andrews.

Studies on the chemical composition and functional significance of mammalian lymph: RUSSELL L. HOLMAN (introduced by Wm. deB. MacNider). The following studies were made in an attempt to throw some light on the function of mammalian lymph and lymphoid tissue. Popliteal lymph nodes of dogs when replaced in the popliteal space after complete severance of all vascular and lymphatic connections rapidly undergo massive necrosis. These nodes usually become infected and may slough out. When, however, all vascular connections are severed but one or more efferent and one or more efferent lymphatic channels remain intact, infection does not ensue and the nodes remain viable. Chemical analyses on lymph flowing to and from these "devascularized" nodes show a sharp drop in reducing substance, bound carbon dioxide and carbon dioxide combining power during its passage through the node and indicate that anaerobic glycolysis is one of the metabolic processes taking place in the viable node. These studies were extended to *in vitro* studies in which the nodes were perfused with artificial "lymph" at varying temperatures and pressures, and the rate of glucose disappearance (loss in reducing substance) under these conditions was compared with that of the thyroid gland under similar conditions. Both the flow through the node and the rate of glucose disappearance increased with pressure, and an elevation of 10 degrees in temperature doubled the rate of glucose disappearance. Similar changes were not observed with the thyroid gland. It is suggested that different oxygen requirements are responsible for the differences observed.

Lattice vibrations in polar crystals: R. H. LYDDANE and K. F. HERZFELD (introduced by Wm. deB. MacNider). While the question of the frequencies of vibration of crystals had been the subject of many investigations, there remained certain points for polar crystals which it was felt should be investigated. In the first place, it did not seem at all clear that the frequencies should be independent of the size and shape of the crystal, since the convergence of lattice sums involving Coulomb interactions between ions is notoriously poor. Secondly, the result for very long waves (Reststrahlen) obtained by Born seemed to contradict a result obtained by Herzfeld in an investigation in a different direction. Thirdly, it seemed of interest to obtain some idea of how the frequency spectrum of an actual crystal looked. The main part of the calculation, the finding of the Coulomb force on a particle in the distorted lattice, was accomplished by an extension of the Madelung method. With a reasonable assumption about the repulsive forces between ions, numerical values for the frequencies of a particular crystal (NaCl) were arrived at. It became also clear that the frequencies, for any actual vibration, are really independent of the size and shape of the crystal, and that the results for long waves are explainable.

Radiative loss by electrons with energies up to 2.4 million volts: CREIGHTON JONES, ARTHUR RUARK and FORREST WESTERN (introduced by Joseph S. Ames). We have studied the radiative loss of energy of electrons which make close collisions with nuclei in a cloud chamber filled with air. Four hundred meters of useful track have been employed. The energy E_0 of the primary electrons lay between 0.4 and 2.4 million electron volts, the average being of the order of one million electron volts. Previous authors found that the cross section for fractional loss greater than 20 per cent. is several times larger than predicted by the Bethe-Heitler formula, which is obtained by the Born approximation. The work of Hulme shows clearly that this approximation gives results which are much too low in the case of large fractional loss. However, in the absence of a more accurate theory we may compare our results and those of Klarmann and Bothe, using Kr and Xe, with the above-mentioned formula. Our results are in better agreement with theory than those of Klarmann and Bothe. (To a good approximation the theoretical result does not depend on atomic number in this energy region.) Several authors have suggested that discrepancies between the experimental and theoretical cross sections for radiation and for scattering require fundamental modifications in the Dirac theory. Others have suggested that such discrepancies are due to non-coulombian interaction between the electron and the nucleus. While such specific interaction may play a part in very close collisions, we believe, in view of the above results, that the main factors in the explanation are simpler and more obvious ones. Even in nitrogen, the chief difficulty in these experiments is multiple scattering in the gas of the chamber. We suggest therefore that the discrepancies are chiefly due (1) to multiple scattering, simulating energy loss; and (2) to the present lack of accurate numerical calculations of the cross section (like those of Jaeger and Hulme, referring exactly to the experimental conditions under which good measurements can be carried out.

An experimental investigation of the rôle of drive in the acquisition and performance of conditioned responses: KARL ZENER (introduced by Walter R. Miles). In recent explanations of higher mental activities by conditioned response theorists the concept of drive has played a crucial rôle. In all these explanations drive has been treated as an internal stimulus, and the nature and the conditions of establishment of its connection with the conditioned response have been considered as identical with those of any other conditioned stimulus. Certain fundamental assumptions regarding these latter points are common to the more elaborated of current-conditioning theories, but they conflict with the presuppositions of other theories of learning based on the study of presumably more complex behavior. The present set of experiments was designed to test some of the more basic of these assumptions in such a way as to differentiate empirically between the implications of these alternative learning theories. The typical Pavlovian technique was employed. The method involved periods of training for the conditioned responses of salivary secretion to food and to acid in states first of low and then of high hunger; with tests of the responses in both states of hunger during each of the training periods. Variation in hunger affects the condi-

tioned secretions based on food and on acid, as well as the concomitant overt behavior, in radically different ways. The effect of variation in intensity of the conditioned stimulus and of constant stimuli other than hunger was compared with the effect of variations in the hunger drive and was also found to be quite different. An analysis of the difference in the effect of change of hunger upon conditioned and unconditioned secretion is presented. The results are inconsistent with the particular assumptions of traditional conditioning theory which the experiments were designed to test. It is felt that they bear significantly upon the interrelation of the general problems of motivation and learning.

Factorial analysis of learning dynamics in animals: ROBERT J. WHERRY (introduced by Walter R. Miles). The number of forces which have been hypothecated to explain animal learning are extremely numerous, one writer having listed over ninety factors. Certain attempts at correlation analysis, however, have endeavored to show that all errors during learning are in large part due to a single factor present *before* learning begins. Other attempts have tried to prove that another single factor developed *during* learning controls its course. In such studies, the correlations used were between the errors on the first run and the total error scores upon all later runs as a unit. Furthermore, such studies have assumed that the factor or factors involved are of a static nature. In the present study, factorial analyses were made of the learning by animals of maze and discrimination problems. These analyses involved correlations of scores on individual trials and alleys, thus bringing out the rise and wane of different factors. Further research indicated by these preliminary analyses is suggested, and its field of probable usefulness is specified.

Recovery sequence after anesthetization. II. Cyclopropane and nitrous oxide: ALBERT C. CORNSWEET (introduced by C. L. Hull). This is a further study of the behavioral tendencies exhibited by albino rats upon anesthetization. A previous study with ether used as the anesthetizing agent was reported at the 1936 meeting of the American Association for the Advancement of Science. In the present study, cyclopropane and nitrous oxide were used. The animals were subjected to varying amounts of the anesthetics until the animals were in a complete state of quiescence. Upon removal from the anesthetization chamber, the animals were stimulated by means of a tweezers-aesthesiometer, and observations were made as to the temporal sequence of the behavioral patterning. In general, the animals portrayed a sequence of movements, in a fairly definite cephalo-caudad direction. Movements in the head region occurred before those of the caudal extremities. These results coincided with the findings of ether anesthetization. The only consistent difference between ether anesthetization and these gases was that the latter's effect upon recovery was more rapid and telescoped. Of especial importance, however, was the fact that the animals upon going under the anesthetic exhibited caudocephalad behavior movements, a sequence that was the reverse of that of recovery. This fact is contrary to medical theory of anesthetization on human subjects, where the order is, supposedly, cerebrum, spinal cord and medulla. No attempt is made to lay down any definite hypothesis, for much more experimentation remains to be done. Many investigators on pre- and post-natal behavior have tended to emphasize one part of the organism's anatomical, structural and psychological constituents more than another; at times slighting the fact that the animal is a totality, a functional whole, and more than automaton made up of discrete units. Explanations have been too reflexological, rather than in terms of an observable whole. Further work is planned, using other species of life and other types of anesthetics, and perhaps then will a comparative correlation and theory be presented.

SPECIAL ARTICLES

THE SECRETION OF IODINE BY THYROID GLANDS CULTIVATED IN THE LINDBERGH PUMP

THE form in which iodine is secreted by the thyroid is not known. The work of some investigators indicates that it is secreted as thyroglobulin. Facts observed by others can not be explained entirely on this basis.

Lunde, Closs and Pedersen[1] have found iodine to be present in normal blood in two forms. Part of it is precipitated with the proteins when these are thrown down by alcohol. Part is alcohol-soluble. The fraction that is precipitated by alcohol has been shown to be greatly above normal in the blood of patients suffering from Graves' disease, and to return to normal as the patients improve under treatment.[1] It is also greater than normal in the blood of experimental animals that have been injected with an extract of anterior pituitary.[2] The alcohol-soluble iodine does not vary much from the normal in either case. These findings, together with the fact that positive precipitin tests for thyroglobulin have been obtained in blood as it is leaving the thyroid,[3] indicate that the compound secreted is thyroglobulin. But, if this is so, it is difficult to understand how the thyroid hormone is able to affect the metabolism of all the cells of the body, for thyroglobulin is a highly indiffusible substance. Moreover, Dodds, Lawson and Robertson,[4] on examining the blood of a large number of patients suffering

[1] G. Lunde, K. Closs and O. C. Pedersen, *Biochem. Zeit.*, 206: 261, 1929.

[2] K. Closs, L. Loeb and E. M. MacKay, *Jour. Biol. Chem.*; 96: 585, 1932.

[3] A. J. Carlson, L. Hektoen and R. Schulhof, *Amer. Jour. Physiol.*, 71: 548, 1925.

[4] E. C. Dodds, W. Lawson and J. D. Robertson, *Lancet*, 2: 608, 1932.

from various types of thyroid disturbance, were unable to find any quantitative relation between the alcohol-insoluble iodine of the blood and the activity of the thyroid as measured by metabolic rate. This suggests the possibility that iodine may be secreted in more than one form.

To obtain further light on this subject, 20 cat and 8 rabbit thyroids were cultivated in the Lindbergh perfusion pump.[5] Then the media in which they were cultivated were fractionated and the various fractions analyzed for iodine.[6] The globulins were precipitated with ammonium sulfate, and the total protein fraction with alcohol. Control fluids were saved in each case and analyzed in the same manner as the perfusion fluids so as to correct for the iodine present in the medium before cultivation. Serum at 40 per cent. concentration in Tyrode's solution was used as the medium in most instances, though 20 and 80 per cent. serum were also tried. The perfusion time was varied from 4 hours to 6 days.

In every instance iodine that was set free by the gland was found in the medium in two forms. Part of it was precipitated with the globulins, and part was found in the globulin-free filtrate. Part was likewise found in the alcoholic precipitate and part in the alcoholic filtrate. The amount that was precipitated from any one medium was the same no matter which precipitant was used. And the sum of that recovered in the precipitate and that found in the filtrate was the same as that found in the unfractionated medium. Thus, gland No. 289 set free 25.2 gammas of iodine. 9.7 gammas of this was found in the precipitate, and 15.6 gammas in the filtrate. As is seen in this example, the iodine that is recovered in the filtrate is no small part of the total secreted. In some experiments it amounted to as much as 80 per cent. of the total, and as much as 40 per cent. of that originally present in the gland.

Presumably, the iodine that is found in the globulin fraction of the medium is contained in thyroglobulin or slightly modified thyroglobulin. That recovered in the filtrate is probably contained in hydrolytic products of the thyroglobulin molecule. It can not be derived from inorganic iodine stored within the gland, for the glands do not contain any such quantity of inorganic iodine. To make certain that this was the case, a number of uncultivated thyroids were fractionated and analyzed. The non-globulin iodine of the glands was found to vary with the total iodine content and constituted only 10 per cent. of the total. That found in the filtrate was often as much as 40 per cent. of the total.

[5] C. A. Lindbergh, *Jour. Exp. Med.*, 62: 409, 1935; A. Carrel, *Jour. Exp. Med.*, 65: 515, 1937.

[6] The method used was a modification of that described by V. Trevorrow and G. J. Faschena, *Jour. Biol. Chem.*, 110: 29, 1935, and 114: 351, 1936.

Because iodine appears in the medium in two forms it is not necessary to conclude that it is actually secreted in two forms. It is conceivable that thyroglobulin might be secreted and hydrolyzed later as cultivation is continued. And, as a matter of fact, a larger portion of the secreted iodine was found in the filtrate in experiments in which the glands were cultivated for 6 days than in those in which they were cultivated for only one day. Yet, when thyroglobulin extracted from cat thyroids was incubated with 40 per cent. serum for two weeks at the various pH values which exist during cultivation no hydrolysis occurred. Apparently, therefore, thyroglobulin is broken down only when the gland is present. To avoid changes that might occur after secretion had taken place experiments of very short duration were made. But whenever any measurable amount of iodine was secreted a part of it was always found in the filtrate. And, when thyreotropic hormone was added to the medium to stimulate secretion, more of the iodine secreted as the result of adding the hormone was recovered in the filtrate than was found in the precipitate. These facts seem to indicate that the iodine is actually secreted in two forms. The increased proportion found in the filtrates in long-continued experiments indicates that the gland continues to act on thyroglobulin that has been secreted as it is repeatedly returned to the gland in the circulating medium.

But if the thyroid secretes iodine in more than one form when it is cultivated outside the body, why has no evidence of such activity been obtained within the animal organism? There is, of course, the possibility that the gland functions differently *in vitro* than it does *in vivo*, and that glands of different animal species function differently. But the most plausible explanation seems to be that the smaller fragments of the thyroglobulin molecule, being more diffusible than thyroglobulin itself, are quickly absorbed by the various cells and tissues within the body and so do not remain in the blood stream.

To summarize: Iodine set free by the thyroid gland during its cultivation in the Lindbergh pump is recovered in the medium in two forms. Part of it is precipitated with the globulins of the medium, and part is found in the globulin-free and also in the protein-free filtrate. Evidence is given which indicates that the latter is contained in degradation products of the thyroglobulin molecule formed as the result of activity of the gland.[7]

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[7] Thanks are due Dr. Carrel and several of the members of his technical staff for cultivating the glands, and assistance in other parts of the work.

PHOTOGRAPHIC NATURE OF TANNING OF THE HUMAN SKIN AS SHOWN BY STUDIES OF MALE HORMONE THERAPY[1]

THE condition of the skin is known to be influenced by the endocrine system, as for examples, the bronzing in Addison's disease of the cortex of the adrenal gland, the acne commonly associated with puberty and the pigmentation changes during pregnancy. Changes in the skin of a hypogonadal patient following the use of synthetic male sex substance testosterone propionate[2] have been reported.[3] A further series of three surgically castrated[4] and four hypogonadal males has been studied. Before treatment the skin in all but two cases was of a characteristic pasty, sallow color, gray and lacking in pink tinge. This was most pronounced in the castrated men. After treatment with testosterone propionate there was a rapid flushing, followed by increased oiliness of the skin and growth of hair on the face, chest, abdomen, arms and legs. All patients presented a more tanned appearance, particularly of the face, neck, hands and exposed parts of the skin. Part of this increased pigmentation is due to "developing" of pigment from previous exposure as indicated by the following history:

Case 1. Orchidectomy was performed in May of 1937, after which time the patient tanned but poorly and burned easily upon exposure to the sun. In August of 1937 he spent part of every morning and afternoon for a week lying on the beach clad in an abbreviated bathing suit of a peculiar cut. Only slight coloration resulted. The patient was examined by the authors several times during December and January, at which time the body skin was of a pasty sallow color. Treatment with male hormone substance was begun in the dead of winter, January 17, 1938. Within three weeks there appeared, along with the bronzing of the face, a tanning of the body save where it had been protected by a bathing suit. The patient had not worn the bathing suit, whose peculiar pattern the tan fitted, or any other bathing suit for five months. Neither had he sunned himself or used a sun-lamp in similar fashion.

Upon withdrawal of the hormone treatment in February of 1938 the flush disappeared from the skin and the tanned areas gradually faded. Subsequent injection and withdrawal periods induced, respectively, coloration and a fading of these areas which had not been exposed to sunlight since the previous August. These phenomena might be accounted for in part by assuming either that tanning consists of a continued production of pigment over a long period of time or that the melanin becomes colorless unless an adequate hormone supply be present.

Graded exposures to a sun-lamp have been given to this and to other patients and a similar series of pigmentation changes have been observed during periods of treatment and withdrawal.

From studies of men with low amounts of testicular secretion it appears that male hormone substance exerts a "developing" action upon the rather colorless material which is laid down in the skin following exposure to the sun or sun-lamp. This "developing" action may be exerted as late as five months after exposure. This indicates that tanning may be a "photographic-like process" of "exposure" and "development," with the sex hormone acting to "develop" color-lacking material laid down in the skin by exposure. Further, the pigmentation is not established continuously but will fade upon cessation of hormone treatment and reappear upon later resumption of treatment.

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[1] Supported in part by the International Cancer Research Foundation.

[2] Furnished by the Ciba Company under the trade-name Perandren.

[3] James B. Hamilton, *Endocrinology*, 21: 649, 1937.

[4] Neal E. Miller, Gilbert Hubert and J. B. Hamilton, *Proc. Soc. Exp. Biol. and Med.*, 38: 538, 1938.

ACTION OF VANADIUM ON TISSUE OXIDATIONS

IF 10–20γ of vanadium in the form of sodium meta vanadate is added to rat or guinea pig liver suspension at pH 6.7 a large extra oxygen uptake occurs. This effect is much less in kidney and absent in brain. Concentration curves indicated that some substance in the liver was oxidized in the presence of vanadium. To prove this the following experiment was done. Rat liver was ground with buffer pH 6.7, squeezed through muslin and centrifuged. The solid was resuspended in 40 cc of water to which 10 cc buffer pH 6.7 was added and centrifuged again. This process was repeated four times and the resultant solid material which was free of hemoglobin and light yellow in color was finally suspended in 15 cc buffer pH 6.7. This constituted the enzyme preparation. The substrate was prepared as follows. A guinea pig liver was chopped and ground in buffer pH 6.7. Enough alcohol was added to make the final concentration 70 per cent. The precipitate was filtered and the alcohol evaporated off in vacuo at 40° C. The resulting suspension was extracted with ether three times, leaving a clear light yellow solution. This solution was then treated with a small amount of Lloyd's reagent and filtered. The filtrate was now almost colorless. It could now be evaporated down to dryness and extracted with boiling 95 per cent. alcohol. The alcohol

extracts the substrate, which is redissolved in water after the alcohol is evaporated off. Table 1 gives the oxygen uptake in c.mm. of the various combinations of enzyme, substrate and vanadium after half an hour at pH 6.7 and 37° C. 0.5 cc enzyme suspension and about 10 per cent. of the amount of substrate present in one guinea pig liver was used in a total volume of 2.0 cc in the Warburg vessels.

TABLE 1

	O_2 uptake c.mm.
Enzyme	0
Enzyme + vanadate	0
Vanadate + substrate	0
Enzyme + substrate	12
Enzyme + vanadate + substrate	119

Work on the chemical identification of the substrate is now proceeding. Experiments have shown that it is probably not an amino acid, amine, simple alcohol or aldehyde, purine, low fatty acid, choline, succinate, cholic acid, citrate, lactate, pyruvate, glucose or ascorbic acid. It is probably a phospholipid.

As vanadium is found in small traces in all tissues these results raise the question whether it has a normal catalytic function in the body and whether it is an essential element.

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A COMPARATIVE STUDY OF THE SUBTERRANEAN MEMBERS OF THREE FIELD GRASSES

A COMPARATIVE study was made of the roots and root hairs in upper soil levels for oats, winter-rye and Kentucky bluegrass. Soil samples 3 inches in diameter and 6 inches deep (42 cubic inches) were taken from the fields by means of a cutting tube, and measurements made of the included subterranean plant parts. Total lengths of both roots and root hairs were used in computing the extent and surface exposed by the underground members. In Tables 1 and 2 the values given are the average of the three soil samples surveyed for each species.

TABLE 1

ROOTS*

	Total number of roots	Total length of roots (ft.)	Total root surface (sq. in.)
Oats	4,700	150	50
Rye	6,400	210	78
Bluegrass	84,500	1,260	330

* Per soil sample (42 cubic inches).

In a comparison of the cultivated rye plants grown in competition with a non-competing greenhouse rye plant, previously surveyed,[1] it was found that the field

[1] H. J. Dittmer, *Am. Jour. Bot.*, 24: 417–420, 1937.

TABLE 2

ROOT HAIRS*

	Total number of root hairs (in millions)	Total length of root hairs (miles)	Total root hair surface (sq. ft.)
Oats	6.3	4.9	3.7
Rye	12.5	10.0	8.2
Bluegrass	51.6	32.0	16.9

* Per soil sample (42 cubic inches).

rye had approximately 5 times the number of root hairs per unit of root length as the non-competing greenhouse plant. However, the indoor plant had far more and longer roots, and consequently a greater total number of root hairs.

Assuming that roots and root hairs were evenly distributed throughout the samples, one cubic inch of soil from this oats field would have approximately 110 roots and 150,000 root hairs, with a combined length of about 630 feet and a surface area of 15 square inches. A similar cube of soil from a field of winter rye would have approximately 150 roots and 300,000 root hairs with a combined length of 1,300 feet and a surface of about 30 square inches. Kentucky bluegrass would have, per cubic inch of soil, approximately 2,000 roots and 1,000,000 root hairs, with a combined length of over 4,000 feet and a surface area of about 65 square inches. When it is considered that these grasses have from 150,000 to 1,000,000 root hairs per cubic inch of soil their importance in the physics of the soil is obvious. From the standpoint of their usefulness as soil binders oats would be least efficient, rye intermediate and bluegrass far superior to either of the others in retarding erosion.

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BOOKS RECEIVED

AVERY, MADALYN. *Household Physics; A Textbook for College Students in Home Economics.* Pp. xv + 439. 378 figures. Macmillan. $3.50.

BAUGH, HANSELL, Editor. *General Semantics;* Papers from the First American Congress for General Semantics, Held at Ellensburg, Washington, March, 1935. Pp. 111. Arrow Editions, New York. $2.00.

JELLINEK, KARL. *Kurzes Lehrbuch der Physikalischen Chemie, Heft I.* Pp. 314. 163 figures. Æ. E. Kluwer, Deventer, Holland. Hfl. 8.50.

Onzième Congrès International de Psychologie, Paris, Juillet, 1937; Rapports et Comptes Rendus. Pp. 571. 25 plates. Imprimerie Moderne, Paris.

SEIFRIZ, WILLIAM. *The Physiology of Plants.* Pp. vii + 315. 95 figures. Wiley. $3.50.

STEINHAUS, H. *Mathematical Snapshots.* Pp. 135. 180 figures. Stechert. $2.50.

THOMPSON, H. W. *A Course in Chemical Spectroscopy.* Pp. vi + 86. 8 plates. Oxford University Press. $2.25.

WATSON, DAVID L. *Scientists Are Human.* Pp. xx + 249. Watts and Company, London. 7s. 6d.

YOUNGER, JOHN E. *Mechanics for Engineering Students.* Pp. x + 461. 362 figures. International Textbook Company. $3.50.